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Rail Maintenance Public Receptor Activity-Based Sampling and Analysis Plan

Operable Unit 6
Libby, Montana, Superfund Site

ENSR Corporation
September 2008
Document No.: 01140-228-100

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ENSR | AECOM

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Approval Page

This Rail Maintenance Public Receptor Activity-Based Sampling and Analysis Plan for Operable Unit 6 of the Libby, Montana, Superfund Site have been prepared for the U.S. Environmental Protection Agency, Region 8, by BNSF Railway Company (BNSF), ENSR, and EMR. Study activities addressed in this Plan are approved.

______________________________ ______________________

Kathryn Hernandez Date
Team Leader, Libby Site

List of Acronyms

ABS	Activity-Based Sampling
ASTM	American Society for Testing and Materials
BNSF	Burlington Northern Santa Fe
cc	cubic centimeters
CDM	CDM Federal Programs Corporation
COC	Chain-of-Custody
CSM	Conceptual Site Model
day/yr	Days Per Year
DQOs	Data Quality Objectives
ED	Exposure Duration
EDD	Electronic Data Deliverable
EF	Exposure Frequency
ERT	Emergency Response Team
ET	Exposure Time
FSDS	Field Sample Data Sheet
FSP	Field Sampling Plan
GO	Grid Opening
GPS	Global Positioning System
hrs/day	Hours Per Day
HASP	Health and Safety Plan
HQ	Hazard Quotient
IDW	Investigation Derived Waste
IRIS	Integrated Risk Information System
ISO	International Organization for Standardization
Kg	Kilogram
L	Liters
L/min	Liters Per Minute
LA	Libby Amphibole asbestos
MCE	Mixed-Cellulose Ester
MET	Meteorological
mm	Millimeter
mm^2	Square Millimeter
MP	Milepost
mph	Miles Per Hour
ND	Non-Detect
NOAA	National Oceanic Atmospheric Administration
NVLAP	National Voluntary Laboratory Accreditation Program
OU	Operable Unit
PCM	Phase Contrast Microscopy
PCME	Phase Contrast Microscopy Equivalent
PLM	Polarized Light Microscopy

PLM-VE	Polarized Light Microscopy – Visual Estimation
PLN	Poisson Lognormal
PM	Project Manger
PPE	Personal Protective Equipment
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RBF	Risk-Based Fraction
RfC	Reference Concentration
RI/FS	Remedial Investigation/Feasibility Study
ROW	Right-of-Way
s/cc	Structures Per Cubic Centimeter
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TEM	Transmission Electron Microscopy
TL	Team Leader
TWF	Time Weighting Factor
UCL	Upper Confidence Limit
UR	Unit Risk
USEPA	United States Environmental Protection Agency
yrs	years
°F	Degrees Fahrenheit

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1.0 Introduction

This document is the Rail Maintenance Public Receptor Activity-Based Sampling and Analysis Plan (SAP) for the collection and analysis of samples of soil and outdoor air in the immediate vicinity of rail maintenance activities that may actively disturb outdoor soil on portions of BNSF Railway Company (BNSF) Right-of-Way (ROW), which is located within Operable Unit (OU) six of the Libby, Montana, Superfund Site. OU6 includes approximately 42 miles of BNSF ROW from Milepost (MP) 1302 to 1341. The ROW extends approximately 50 feet on either side of the track. The majority of this track travels along the Kootenai River and passes through the towns of Libby and Troy, Montana. The planned rail maintenance activities will encompass track between MP 1312 to MP 1341, which runs through both rural and urban areas. **Figure 1-1** depicts the locations of the scheduled rail maintenance activities.

This work is being conducted in advance of the negotiation of an Administrative Order and a Statement of Work for OU6 with the United States Environmental Protection Agency (USEPA). BNSF has a unique opportunity to collect site-specific data in advance of the finalization of the Order as maintenance of track between MP 1312 to MP 1341 is planned to begin on September 17, 2008 and end on September 23, 2008. Because of the track protection provided by the railroad during the maintenance activities (i.e., active trains will not be using those sections of track), sampling can occur along the ROW in a manner that adheres to health and safety protocols. BNSF agrees with USEPA that conducting air sampling during this maintenance event, concurrent with the collection of soil samples, will provide valuable information for scoping the Remedial Investigation/Feasibility Study (RI/FS) Work Plan for OU6.

This SAP addresses public receptors (e.g., trespassers, near-by residents) that may be exposed to asbestos in air as a result of BNSF rail maintenance activities. As this is an active BNSF railway, and the rail maintenance workers are BNSF employees that are subject to BNSF health and safety requirements, worker receptors are not addressed in this SAP.

This SAP contains the elements required for both a field sampling plan (FSP) and quality assurance project plan (QAPP). This SAP has been developed in accordance with the USEPA Requirements for Quality Assurance Project Plans (USEPA 2001), the Guidance on Systematic Planning Using the Data Quality Objectives Process – USEPA QA/G4 (USEPA 2006), and the project documents currently in place for the Libby Asbestos Site. The project-specific procedures for this SAP are presented in Appendix A. The SAP is organized as follows:

Chapter 1.0 – Introduction

Chapter 2.0 – Background and Purpose of Investigation

Chapter 3.0 – Data Quality Objectives (DQOs)

Chapter 4.0 – Sampling Program

Chapter 5.0 – Laboratory Analysis and Requirements

Chapter 6.0 – Assessment and Oversight

Chapter 7.0 – Data Validation and Usability

Chapter 8.0 – Project Schedule

Chapter 9.0 – References

2.0 Background and Purpose of Investigation

Libby is a community in northwestern Montana that is located near a large open-pit vermiculite mine. Vermiculite from this mine contains varying levels of a form of asbestos referred to as Libby Amphibole asbestos (LA). Historic mining, milling, and processing operations at the Site are known to have caused releases of vermiculite and LA to the environment that have caused a range of adverse health effects in exposed people, including not only workers at the mine and processing facilities (Amandus and Wheeler 1987, McDonald et al. 1986, McDonald et al. 2004), but also in residents of Libby (Peipens et al. 2003).

The mine (located 7.5 miles north of Libby) was active from the 1920s through 1990. Processed ore from the mine was trucked down Rainey Creek Road to the Screening Plant on the Kootenai River, which separated milled ore into various sizes. Ore was then moved by conveyor belt across the Kootenai River to a loading facility, where it was put on rail cars and shipped either to the Grace Export/Expansion Plan in Libby OU1 or across the country by rail. Based on this information, ore spillage during rail transit could have deposited LA along the OU6 BNSF ROW (CDM 2007).

To date, the only sampling event focused on the OU6 ROW occurred in April 2001, when asbestos characterization soil samples were collected from eight locations along the ROW, as presented in **Figure 2-1** and Table 2-1 of the CDM Federal Programs Corporation (CDM) Data Summary Report for OU6 (CDM 2007). Asbestos was not detected in any of the ROW samples, which were collected from MP1312 to MP1319, all of which are located east of the Libby Railyard.

2.1 Purpose of Investigation

Measurement of asbestos in air in the immediate vicinity of an active soil disturbance is referred to as "activity-based sampling" (ABS). BNSF has a unique opportunity to collect site-specific ABS data in advance of the finalization of the Administrative Order and the Statement of Work for OU6. Maintenance of track between MP 1312 to MP 1341 (which runs through both rural and urban areas) is planned to begin on September 17, 2008 and end on September 23, 2008. Because of the track protection provided by the railroad during the maintenance activities, sampling can occur along the ROW in a manner that adheres to health and safety protocols. Under track protection, a "Track and Time" permit is issued by the BNSF dispatcher to authorize occupancy of the track by on-track equipment and employees, and ensures that active trains will not be using that section of track during that period of time. BNSF agrees with USEPA that conducting ABS during this maintenance event, concurrent with the collection of soil samples, will provide valuable information for scoping the RI/FS Work Plan for OU6.

Therefore, this SAP is focused on collection of the data needed to support an evaluation of exposure and risk associated with rail maintenance activities, as well as pedestrian activities in the absence of rail maintenance activities. In addition, collection of these data will help characterize the nature of asbestos in air and soil within the planned rail maintenance areas of OU6.

Currently, potential public receptors include trespassers walking along or across the ROW during rail maintenance activities, residents who may be located near rail maintenance activities, and pedestrian traffic along the ROW in the absence of rail maintenance activities. There are several different exposure pathways by which current human receptors within the OU6 ROW might be exposed to residual LA contamination in outdoor soil during the planned maintenance activities. However, the most significant pathway is expected to occur when inhaling ambient air in the immediate vicinity of an active soil disturbance that causes LA fibers to be released from soil into air.

Asbestos may be released to the air from soil or ballast during rail maintenance activities, from non-rail activities conducted within the ROW (walking, etc.), or from air turbulence caused by passing trains. Note, during maintenance activities that occur where a siding exists, there is a possibility of train movement on the main track. However, in these instances, the train will travel at a cautious speed through the maintenance area, which will minimize turbulence. Passing trains during sampling will be noted in the field logbook. The majority of rail maintenance activities will result in disturbing ballast along the track. However, there are rail maintenance-related activities that could disturb the soils within the ROW (support vehicle traffic, vegetation clearing for fire breaks, etc.). A more complete conceptual site model will be developed as part of the RI/FS Work Plan for OU6.

Because this SAP has been prepared in advance of the Administrative Order for OU6 to take advantage of the planned rail maintenance activities, the primary purpose of this SAP is to collect ABS outdoor air data as part of OU6 maintenance activities to support risk assessment and risk management decisions, as well as provide valuable information in scoping the RI/FS Work Plan for OU6. Additional exposure scenarios will be considered under the RI for OU6.

2.2 Overview of Existing Data

As mentioned in Section 2.0, to date, the only sampling event focused on the OU6 ROW occurred in April 2001, when asbestos characterization samples were collected from eight locations along the ROW, as presented in **Figure 2-1** and Table 2-1 of the CDM Data Summary Report for OU6 (CDM 2007). The samples were submitted to Clayton Group Services for analysis by the “EPA asbestos in soil method,” which involved separating the samples into coarse, medium, and fine fractions and conducting a combination of transmission electron microscopy (TEM) semi-quantitative analyses and polarized light microscopy (PLM) Method 600 analyses on those fractions. Asbestos was not detected in any of the ROW samples, which were collected east of the Libby Railyard from MP1312 to MP1319. The detection limit for these results is not known at this time.

2.3 Correlation of Soil and Air Data for Asbestos

As noted above, exposure and risk estimates for asbestos present in soil are best characterized by air measurements; thus, the focus here on ABS. However, soil measurements are useful for determining nature and extent, and for informing remedial decisions. As it is impractical to conduct ABS along the full length of the OU6 ROW, this SAP includes plans for collecting soil samples within the ROW in areas where ABS will occur. Ideally, a correlation can be made between levels of asbestos in soil and levels of asbestos in air for the activities to be sampled. However, USEPA has attempted to develop such a correlation within OU4, with limited success. The following is excerpted from USEPA’s OU4 SAP (USEPA 2007a).

“USEPA has collected some initial data on the levels of LA that occur in air in association with active disturbance of outdoor soil (USEPA 2005). In brief, these data include ABS personal and stationary air samples that were collected in association with three types of outdoor soil disturbance activities (digging, mowing, and raking) at several different locations [though not within OU6] with varying levels of LA in the soil. Air samples were evaluated by transmission electron microscopy (TEM) with an average sensitivity of about 0.001 structures per cubic centimeter (s/cc). Soil samples were collected from the same location as the soil disturbance and these were evaluated by polarized light microscopy (PLM) in accord with site-specific standard operating procedures (SOPs) that have been developed for use at Libby. This site-specific approach is referred to as polarized light microscopy-visual area estimation (PLM-VE). In this approach, soil levels are categorized semi-quantitatively into “bins”, as follows:

PLM-VE Bin	Meaning
A	Asbestos not detected
B1	Asbestos detected at a level ≤ 0.2 %
B2	Asbestos detected at a level > 0.2 % and < 1 %

C	Asbestos is detected at a level ≥ 1 %
Notes: PLM-VE - polarized light microscopy-visual area estimation; ≤ - less than or equal to; > - greater than;< - less than; ≥ - greater than or equal to; % – percent	

"The initial data [1] are summarized in **Figure 2-1**. As seen, there is wide variability (4-5 orders of magnitude) in the levels of LA seen in ABS air. However, there is an apparent trend toward higher levels of LA in air as a function of increasing LA levels in soil (as indicated by PLM-VE measurements of the soil).

"While informative, these initial data are not sufficient to support reliable risk assessment or risk management decisions for the outdoor soil disturbance activity [for OU4] because of the following data limitations:

- Not enough samples have been collected to adequately limit statistical uncertainty
- Not enough samples have been collected to ensure adequate spatial and temporal (seasonal) representativeness of the data
- ABS locations where soil is characterized as "Bin A" [non-detect (ND)] by PLM-VE may actually represent a range of residual soil contamination levels, since some may be characterized by the absence of visible vermiculite, while others may be characterized by the presence of visible vermiculite. Additionally, the PLM-VE method, which has a practical quantitation limit of about 0.2 percent (weight) for LA, may simply not be sensitive enough to identify levels in soils that, when disturbed, generate asbestos levels in air that are of potential concern."

Thus, in addition to the primary purpose that this SAP seeks to address, which is collecting sufficient ABS outdoor air data as part of OU6 maintenance activities to support risk assessment and risk management decisions for public receptors, as well as provide valuable information in scoping the RI/FS Work Plan for OU6, soil data will also be collected and analyzed for asbestos to determine whether a correlation between asbestos concentrations in outdoor air during ABS and collocated soils can be made.

To date, the majority of the ABS soil sampling that has been conducted for the Libby Asbestos Site has consisted of the collection of 30-point composite samples. USEPA has noted (K. Hernandez, USEPA, personal communication) that ABS results for asbestos may better correlate with discrete soil sample results rather than composite soil sample results. Therefore, as noted in Section 4 of this SAP, discrete soil grab samples will be collected under this SAP for comparison with the ABS sampling results.

[1] These data have not yet been fully validated. Thus, the data should be considered tentative and revisions may occur.

3.0 Data Quality Objectives

DQOs are statements that define the type, quality, quantity, purpose and use of data to be collected. The design of a study is closely tied to the DQOs, which serve as the basis for important decisions regarding key design features such as the number and location of samples to be collected and the chemical analyses to be performed. In brief, the DQO process typically follows a seven-step procedure, as follows:

1. State the purpose that the study is designed to address
2. Identify the decisions to be made with the data obtained
3. Identify the types of data inputs needed to make the decision
4. Define the bounds (in space and time) of the study
5. Define the decision rule which will be used to make decisions
6. Define the acceptable limits on decision errors
7. Optimize the design using information identified in Steps 1-6

Following these seven steps helps ensure that the project plan is carefully thought out and that the data collected will provide sufficient information to support the key decisions which must be made. The following paragraphs implement the DQO process for this project.

3.1 State the Purpose

In order to help determine what, if any, remedy may be needed in OU6, information is needed to characterize the level of risk from outdoor exposures during rail maintenance activities to members of the public. Based on the conceptual site model (CSM) provided for OU6 in the CDM report (CDM 2007) and a refined CSM as presented in **Figure 3-1**, the receptors to be addressed by the ABS under this SAP are:

- Trespassers (onlookers) who access the ROW at rail maintenance locations during rail maintenance activities. They may be onlookers to the rail maintenance activities or they may be crossing the ROW.
- Residents who are located near rail maintenance activities. These residents would not access the ROW, but their property may be in close proximity to the ROW.
- Trespassers (pedestrians) who may walk along the ROW in the absence of rail maintenance activities (note that ABS measurements taken by USEPA Region 10 at the Swift Creek Site (USEPA 2007b) simulated this activity with one individual trailing the other for a one-mile stretch adjacent to Swift Creek; thus, a two person team will be used to address this trespasser/pedestrian scenario).

Additional receptors and scenarios will be considered in the development of the conceptual site model for the RI/FS Work Plan for OU6.

The ROW media to be sampled are:

- Breathing zone air via personal sampling monitors
- Soil samples in the vicinity of the ABS
- Ambient air from stationary monitors in the vicinity of the ABS

It should be noted that the rail lines are laid upon several inches of ballast material, which is not amenable to direct sampling for asbestos (CDM 2007). Therefore, the soil samples will be collected from the ROW locations adjacent to the ballast, in areas where a receptor could walk. The source of asbestos in air may be different for each receptor population, as presented in **Figure 3-1**:

- Trespasser watching rail maintenance activities – because the trespasser is assumed to be located within the ROW, sources of asbestos in air may be from the ballast areas and/or the ROW soil areas.
- Residents who are located near rail maintenance activities – because the resident is assumed to be located adjacent to the ROW, sources of asbestos in air may be from the ballast areas and/or the ROW soil areas.
- Trespassers walking along the ROW – because this receptor is assumed to walk along the ROW in the absence of rail maintenance activities, the sources of asbestos in air is likely to be from the soils in the ROW.

Thus, the primary purpose that this SAP seeks to address is in collecting ABS outdoor air data and soil data as part of OU6 maintenance activities [between MP 1312 to MP 1341] to support risk assessment and risk management decisions for public receptors, as well as provide valuable information in scoping the RI/FS Work Plan for OU6.

3.2 Identify the Decisions

The work described in this SAP is being conducted in advance of an Administrative Order for OU6, and is being conducted to take advantage of planned rail maintenance activities. The purpose is to provide data to help scope the work to be conducted under the RI/FS Work Plan for OU6. The purpose of the RI/FS is to collect information necessary to address the decision of whether a remedy is needed with OU6 to protect the health of either rail workers who live in Libby doing maintenance activities or area residents who live or recreate near the rail road.

However, the data to be collected during this SAP effort are intended to support the following decisions:

1. Will the current strategy to collect soil and air samples during maintenance work within OU6 accurately characterize the nature of LA within the planned rail maintenance areas of OU6 and support a correlation between soil and air concentrations of asbestos during ABS?

   Note: The method that USEPA currently recommends for estimating excess risk of lung cancer and mesothelioma from inhalation exposure to asbestos in air is described in Integrated Risk Information System (IRIS) (2008). This method is currently undergoing review, and the approach may be revised in the future as new methods are developed and as new toxicity data on asbestos are obtained. In addition, the USEPA has not yet developed a method for assessing non-cancer risks from inhalation exposure to asbestos. Thus, it is important to stress that all evaluations of protectiveness that are based on currently available risk assessment methods should be viewed as interim, and these interim decisions may be revised in the future as methods and data for assessing the cancer and non-cancer risks of asbestos are improved.

2. Will the current sampling strategy support an evaluation of exposure and risk for OU6 potential human receptors, including residents located near the maintenance activities, trespassers walking along or across the ROW during maintenance activities, and trespassers walking on the ROW in the absence of rail maintenance activities?

3.3 Identify the Types of Data Needed

The data needed to achieve the objectives of this effort consist of accurate and reliable measures of LA in outdoor air during ABS activities at different locations along the ROW where maintenance activities are planned, as well as measures of LA in outdoor air during ABS activities independent of rail maintenance activities (e.g., trespasser walking on the ROW). In addition, data from soil samples collocated with ABS activities are needed. The following sections identify key attributes of the data needed for this effort.

3.3.1 Sampling Locations

3.3.1.1 Rail Maintenance Locations

Sampling locations are to be determined by the locations of the planned rail maintenance activities. As these locations are defined by BNSF to meet rail operational needs, the exact locations identified herein are subject to change. However, the goal is to conduct ABS and soil sampling at the majority, if not all, of the locations. Topography, accessibility and health and safety requirements will determine whether all rail maintenance locations can be safely sampled.

As of this writing, there are approximately 12 planned maintenance locations between MP 1312 and MP 1341, each location requiring approximately one-half of a working day to complete the maintenance activities. The majority of the maintenance activities at each location will involve track replacement using a Steel Gang to remove and replace the rail and a Surface Gang to tamper the ballast and regulate the track. See **Table 3-1** for a general description of the activities planned at each location.

3.3.1.2 Non-Rail Maintenance Locations

To take advantage of the track protection afforded during the rail maintenance activities, BNSF plans to conduct ABS for the scenario of pedestrians that may walk the tracks. The location of this activity will be identified on a daily basis, determined by where the rail maintenance work is to occur and the area of track with track protection.

3.3.2 Types of Samples

For each receptor scenario, personal air samples, ROW soil samples, and stationary air samples will be collected.

3.3.2.1 Air Samples

Experience at Libby and at other sites has demonstrated that, in general, personal air samples (i.e., samples that collect air in the breathing zone of a person) tend to be higher in concentration than air samples collected by a stationary monitor, especially if the person is engaged in an activity that disturbs an asbestos source such as contaminated soil. Because of this, this SAP will focus on the collection of personal air samples during ABS, as well as characterizing perimeter conditions using stationary monitors.

3.3.2.2 Soil Samples

In an endeavor to determine if there is a correlation between the ABS addressed by this SAP and the levels of asbestos in soil, discrete soil grab samples will be collected for each rail maintenance activity area and for each trespasser area of the ROW away from rail maintenance activities, but under track protection.

3.3.3 Target Analyte List

Each air and soil sample that is collected must be analyzed for asbestos particles. Specific methods and counting rules are provided in Section 5.0. Results should include the size (length, width) of each particle, along with the mineral classification (LA, other amphibole, chrysotile).

3.3.4 Types of Soil Disturbances

Workers, onlooker trespassers and pedestrian trespassers may disturb soil within the ROW by several different activities. Conceptually, the ideal data set would include ABS data from many different types of disturbance that span the full range of intensities that may occur during maintenance activities, as well as onlooking/pedestrian trespasser activities within the ROW. However, it is not feasible to evaluate every possible type of disturbance. Rather, this assessment will focus on three standardized activities which are considered to be realistic examples of relatively vigorous disturbances:

- Rail maintenance activities, which are detailed in **Table 3-1**
- An onlooker trespasser walking along and across the OU6 ROW in areas where maintenance activities are occurring
- A pedestrian trespasser walking along the ROW in the absence of rail maintenance activities

3.3.5 Soil Condition Data

It is expected that the amount of dust (and asbestos) released from an ABS event may depend in part on the condition of the soil at the time of the ABS event. In order to help characterize this source of variability, and potentially to allow for some degree of normalization between locations, the following data items are needed for each ABS test area:

- Location of sample collected with respect to the proximity to ballast
- Nature and extent of soil vegetative and other cover (documented in field notes and photographs)
- Soil moisture
- Soil texture

3.4 Define the Bounds of the Study

3.4.1 Spatial Bounds

The spatial bounds of this study are restricted to the extent of the railroad ROW (approximately 50 feet on either side of the track) between MP 1312 and MP 1341 of OU6 where rail maintenance activities will occur in September 2008. This length traverses rural areas between Libby and Troy, as well as urban areas of Troy.

3.4.2 Temporal Bounds

Estimation of human health risk from exposure to LA in outdoor air following a series of active outdoor soil disturbances will be based on the average concentration that occurs across the series of disturbances. Because the level of LA in outdoor ABS air may depend on factors that vary seasonally (disturbance patterns, soil moisture, wind speed, humidity, etc.), the data set needed for this effort should ideally consist of multiple samples from each area, spanning a range of time points and meteorological conditions. Note that rail maintenance activities are not regularly scheduled during the winter months. However, because OU6 is an active rail line, the sampling proposed in this SAP is limited to times and locations where rail maintenance is planned. This is due to two factors: rail maintenance ABS must be conducted during rail maintenance activities, and for health and safety reasons, track protection that is afforded during rail maintenance will be used to conduct ABS for exposure scenarios independent of maintenance activities (e.g., pedestrian trespasser walking on the ROW). While ideally, samples collected as part of the upcoming rail maintenance activities should be collected under conditions when the soil is relatively dry (less than 1/10-inch of rain within the past 36 hours), and a field moisture deficiency of at least 50 percent (see Section 4.2.2, below) to help ensure that the data are not biased low, samples will be collected no matter what preceding rainfall may occur. Prior weather conditions will be noted in the field notebooks. However, ABS will not be conducted if it is actively raining. During days when outdoor ABS activities are scheduled, meteorological (MET) weather station data will be downloaded from the local National Oceanic Atmospheric Administration (NOAA) station, LBBM8, to calculate the total accumulation of rain. During sampling activities, rain accumulation will be monitored onsite by a portable MET station.

3.5 Define the Decision Rule

The decision rule for evaluating human health risks from disturbance of outdoor soils during rail maintenance activities is:

If the level of risk to maximally-exposed receptors during rail maintenance activities within the OU6 ROW, when combined with the level of risk from other applicable exposure pathways (these are of interest only if that receptor is also a local Libby resident), does not exceed a cancer risk of 1E-04 or a non-cancer Hazard Quotient (HQ) of 1.0, then risks from the rail maintenance activities in OU6 will be considered acceptable. If the total risk exceeds a cancer risk of 1E-04 or an HQ of 1.0, then the feasibility of further reducing exposure from either the outdoor soil disturbance pathway and/or the other applicable exposure pathways at that location shall be assessed.

At present, USEPA has not developed a quantitative procedure for evaluating non-cancer risks, but has developed a method for quantification of cancer risk (IRIS 2008). The basic equation is:

$$\text{Risk(i)} = \text{C(i)} \cdot \text{TWF(i)} \cdot \text{UR(i)}$$

where:

Risk(i)	=	Risk of cancer that results as a consequence of exposure from specified exposure scenario "i"
C(i)	=	Average concentration of asbestos fibers in air in units of structures per cubic centimeter (s/cc) during exposure scenario "i"
UR(i)	=	Unit Risk $(s/cc)^{-1}$ that is appropriate for exposure scenario "i"
TWF(I)	=	Time weighting factor for exposure scenario "i". This factor accounts for less-than-continuous exposure during the exposure interval.

Because each person can be exposed from more than one source, the total cancer risk is calculated by summing the risks from each exposure pathway that applies:

$$\text{Total risk} = \Sigma \text{ Risk(i)}$$

As noted above, this document is focused on collection of air data representative of the concentration of asbestos that occurs in the breathing zone for human receptors who are engaged in activities that disturb soils within the ROW. These data will be used to evaluate the risk from the soil-disturbance pathway. This risk estimate will, in turn where appropriate, be combined with risk estimates for other pathways to estimate total exposure. The soil data will be used to determine exposure (where a correlation with ABS results can be established) and identify remedial areas in the RI/FS process, should that be needed.

As noted above, because of limitations in the current methods for assessing risks from asbestos, all decisions regarding risk levels are considered interim, and interim decisions may be revisited in the future as new methods and new data become available.

3.6 Define the Acceptable Limits on Decision Errors

In making decisions about the long-term average concentration of LA in outdoor ABS air and the level of health risk associated with that exposure, two types of decision errors are possible:

- A **false negative** decision error would occur if a risk manager decides that exposure to ABS air is not of significant health concern, when, in fact, it is of concern.
- A **false positive** decision error would occur if a risk manager decides that exposure to ABS air is above a level of concern, when, in fact, it is not.

USEPA is most concerned about guarding against the occurrence of false negative decision errors, since an error of this type may leave humans exposed to unacceptable levels of LA in outdoor air. For this reason, it is anticipated that decisions regarding this pathway will be based not only on the best estimate of the long term average concentration, but will also consider the 95% upper confidence limit (UCL) of the long-term average concentration. Use of the UCL to estimate exposure and risk helps account for limitations in the data, and provides a margin of safety in the risk calculations, ensuring that risk estimates are unlikely to be too low.

USEPA is also concerned with the probability of making false positive decision errors. Although this type of decision error does not result in unacceptable human exposure, it may result in unnecessary expenditure of resources. For the purposes of this effort, the strategy adopted for controlling false positive errors is to set a goal that, if the exposure estimate based on the 95% UCL is above USEPA's level of concern for this pathway, then the UCL is not larger than 3-times the best estimate of the mean. If the 95% UCL is at or above the range that is of potential concern, and the UCL is greater than 3 times the best estimate of the mean, then it will be concluded that there is a substantial probability of a false positive decision error and that more data may be needed to strengthen decision-making.

3.7 Optimize the Design

3.7.1 Limiting the Uncertainty in Estimates of Long-Term Average Concentration

The method used to compute the UCL of a set of outdoor air samples depends on the statistical properties of the data set. For samples from the Libby Site, the data are believed to be reasonably well represented by a Poisson lognormal (PLN) distribution, and the parameters of the PLN can be derived using a fitting procedure described by Haas et al. (1999). The fitted parameters (μ and σ) may then be used to compute the UCL of the mean using the approach for lognormal data sets described in USEPA (1992). Based on this approach, the ratio of the UCL to the mean of a data set (an indication of the statistical uncertainty in the data) is given by:

$$\frac{UCL}{Mean} = \exp\left(\sigma\, H / \sqrt{(n-1)}\right)$$

where:

σ = log standard deviation of the measured values

H = statistic described in USEPA (1992)

n = number of samples

Figure 3-2 illustrates the ratio of the UCL to the mean as a function of n for an assumed value of σ of 2.0 (geometric standard deviation = 7.4). As seen, the ratio (a measure of uncertainty) approaches a value of about 2 as the number of samples approaches about 80 to 100, and continues to decline slowly as the number of samples increases.

USEPA is currently evaluating this statistical approach (K. Hernandez, USEPA, personal communication); however, as it is a conservative approach to estimating the distribution of an environmental data set, it can be used for screening level purposes here.

For this SAP, the number of samples is limited by the extent of the rail maintenance activities. However, the data, including the number of samples collected, will be reviewed in light of this information, and will be used to inform the scope of the RI/FS Work Plan.

3.7.2 Estimating the Required Analytical Sensitivity for Outdoor Air

For the purposes of this effort, the analytical sensitivity that is needed for analysis of ABS air samples should be sufficient to ensure reliable detection and quantification if risks from outdoor ABS air approach or exceed a level of health concern. The choice of the level of concern is complicated by the fact that potential human receptors related to rail maintenance activities within the OU6 ROW may be exposed to asbestos via more than one pathway, and hence, risk management decisions must consider the total (cumulative) risk from all pathways combined.

With this in mind, the target level of concern for the outdoor ABS pathway alone is set at a cancer risk of 1E-05 (1 in 100,000) or a non-cancer HQ of 0.1 for receptors that may be residents of Libby. That is, the target sensitivity is selected such that, if the true concentration of LA in outdoor ABS air corresponds to a risk that could contribute risk 1/10 the total level of concern (1E-04), the concentrations in air would be readily detectable and quantifiable with good confidence. If the true concentration corresponds to a risk that is less than 1/10 the total level of concern, exact quantification of the pathway becomes less important.

The concentration of LA in outdoor ABS air that is associated with a risk level of 1E-05 is derived from the basic risk equations described above, simply by solving for the concentration that yields a risk of 1E-05:

$$1\text{E-}05 = C(\text{air}) \cdot \text{TWF} \cdot \text{UR}$$

$$C(\text{air}) = 1\text{E-}05 / (\text{TWF} \cdot \text{UR})$$

Note that the type of fibers included in this concentration is defined by the risk model. For example, the current USEPA approach is based on phase contrast microscopy (PCM) fibers, which are defined as asbestos fibers longer than 5 micrometers (um), thicker than 0.25 um, and with an aspect ratio greater than 3:1. For convenience, the fibers used in a risk model are called “risk-based fibers”.

In most cases, the risk-based fibers are only a sub-set of the total asbestos fibers present in air. The fraction of fibers that are risk-based is referred to as the “risk-based fraction” (RBF):

$$\text{RBF} = C(\text{risk-based}) / C(\text{total})$$

At the Libby site, current analytical methods focus on measuring the concentration of total fibers, and sufficient data have accumulated to estimate the RBF with good accuracy. Thus, the concentration of risk-based fibers may be calculated from a measure of total fibers as follows:

$$C(\text{risk-based}) = C(\text{total}) \cdot \text{RBF}$$

This approach provides an estimate of the concentration of risk-based fibers that has lower statistical uncertainty than if only risk-based fibers were measured, and may be applied to any risk model that may be of interest.

Combining these two equations and rearranging to solve for the concentration of concern associated with a specified risk level (1E-05) for this exposure scenario yields the following:

$$\text{Concentration of Concern (Total TEM s/cc)} = (1\text{E-}05) / (\text{RBF} \cdot \text{TWF} \cdot \text{UR})$$

For planning purposes, it is conservatively assumed that the TWF for exposure to ABS air is 0.04. This value would correspond to an outdoor soil disturbance frequency of 8 hours per day (hrs/day), 60 days per year (days/yr) for 50 years (yrs). It is considered likely that the maximally-exposed rail worker who is also a local resident will have soil disturbance exposures that are considerably less than this assumption, although this value might be realistic for a rail worker resident who regularly engages in outdoor yard or soil disturbance activities. Regardless, the conservativeness of the ROW exposure assumptions is appropriate when considering the cumulative exposure and risk to a Libby resident.

Based on USEPA’s currently recommended cancer risk model (IRIS 2008), the unit risk factor for lifetime exposure is 0.23 per phase-contrast microscopy (equivalent) (PCME) s/cc. Based on particle size data from the Libby Site, the fraction of total LA fibers in air that are PCME fibers is about 0.45 (i.e., this is the RBF). Thus, the concentration of concern for total LA in outdoor ABS air would be about:

Concentration in air of cancer concern = (1E-05) / (0.45 x 0.04 x 0.23 s/cc) = 0.0024 s/cc

Based on this, the target analytical sensitivity for evaluating cancer effects is 0.0024 cc^{-1}. However, as noted previously, this concentration of concern may be revised in the future as methods and data for asbestos cancer risk evaluation are improved. **In order to at least partially account for potential future changes, the target analytical sensitivity for this SAP for evaluating cancer risk is set to a somewhat lower value of 0.001 cc^{-1}.**

For non-cancer effects, the basic risk equation is:

$$HQ = C \bullet (ET/24 \bullet EF/365 \bullet ED) / RfC$$

where:

HQ = hazard quotient (dimensionless)

C = long-term average concentration of asbestos in air (s/cc), expressed in the same units as used in the reference concentration (RfC)

ET = exposure time (hrs/day)

EF = exposure frequency (days/yr)

ED = exposure duration (yrs)

RfC = reference concentration (s/cc-yrs)

USEPA toxicologists are currently working to develop an RfC for asbestos based on available data on LA and other forms of asbestos, but at present, no value has been finalized or approved for use. Therefore, it is not yet possible to compute an analogous level of concern for this endpoint. In the absence of data, it is tentatively assumed that the target analytical sensitivity that is adequate for evaluating cancer risk will also be sufficient for evaluating non-cancer risks. This assumption will be re-visited when an RfC is approved for use.

According to the Activity-Based Air Sampling for Asbestos (USEPA Emergency Response Team [ERT] #2084 with modifications) SOP presented in Appendix A, the following formula may be used to calculate the analytical sensitivity:

$$S = \frac{A_t}{KA_gV}$$

where:

S = Analytical sensitivity (0.001 cc^{-1})

A_t = Active area of the collection media or filter (mm^2)

A_g = Mean area of the grid openings examined (mm^2)

K = Number of grid openings examined (unitless)

V = Volume of air sampled (cc)

Assuming that most ABS samples will be collected in the field on filters that are 385 square millimeters (mm^2), the typical grid opening is 0.01 mm^2, and that the collection volume for a four-hour event is about 1,200,000 cc or 1,200 liters (L) [240 minutes x 5 liters per minute (L/min)], the number of grid openings (GOs) that will require analysis in order to achieve a target analytical sensitivity of 0.001 cc^{-1} is about 32.

If the soil disturbance results in high dust levels in air, the filter may be overloaded, requiring an indirect preparation. In this case, the number of GOs or filter area needed to achieve the target sensitivity may be 3- to 100-fold higher. In the event that the number of GOs or filter area requiring analysis becomes time- or cost-prohibitive, it is generally better to increase the analytical sensitivity somewhat (e.g., 0.002 or 0.003 cc^{-1}), rather than decrease the number of samples collected and analyzed (USEPA 2007a).

3.7.3 Refinements to the Design as Data are Collected

In accord with USEPA's DQO process, it is expected that the ABS program described in this document may be modified periodically as data are obtained, or as field conditions dictate (operations activities and health and safety concerns).

4.0 Sampling Program

The following sections summarize field activities that BNSF will perform during the outdoor ABS investigation. All activities will be performed in accordance with this SAP. Field personnel will refer to the following OU6 Rail Maintenance SAP Project-Specific Procedures sections presented in Appendix A for details regarding requirements referenced in this SAP:

QAPP Section Number	Section Title
1.0	Field Planning Meetings
2.0	Field Team Training Requirements
3.0	Equipment Decontamination
4.0	Field Logbooks
5.0	Field Sample Data Sheets (FSDSs)
6.0	Photographic Documentation
7.0	Global Positioning System (GPS) Point Collection
8.0	Equipment Calibration
9.0	Field Equipment Maintenance
10.0	Handling Investigation Derived Waste (IDW)
11.0	Field Sample Custody and Documentation
12.0	Sample Packaging and Shipping
13.0	Modification Forms
14.0	Laboratory Analysis and Requirements - Related QA/QC Procedures
15.0	Laboratory Custody Procedures and Documentation
16.0	Documentation and Records
17.0	Data Recording, Management and Reporting

The project-specific procedures and Libby SOPs to be followed during this sampling event are included as attachments to Appendix A, and are listed in the Table of Contents therein.

4.1 Pre-Sampling Activities

Prior to beginning field activities, sampling locations will be selected, community coordination will be conducted by USEPA, a field planning meeting will be conducted, any required trainings will be conducted, and an inventory and procurement of supplies will be performed. In addition, the Health and Safety Plan (HASP) (presented in Appendix B) will be reviewed and acknowledged by all members of the sampling team.

4.1.1 Selection of Sampling Locations

As discussed in Section 3.3, sample locations are dictated by the rail maintenance activities schedule.

4.1.2 Community Coordination

The work described in this SAP will be conducted on BNSF ROW property. Private property will not be accessed. If USEPA feels it is appropriate, it may chose to notify the community that this work has been scheduled.

4.1.3 Field Planning Meeting

A field planning meeting will be conducted in accordance with the procedures detailed in Section 1.0 of the Project-Specific Procedures, as presented in Appendix A. Details about the objectives of the sampling, plans for sample collection, and Health and Safety considerations will be shared with all members of the sampling team.

4.1.4 Training Requirements

Training requirements described in Section 2.0 of the Project-Specific Procedures, as presented in Appendix A, will apply to personnel conducting sample collection activities described in this SAP. In addition, any personnel accessing the ROW during the rail maintenance activities must have the following BNSF rail-specific training:

- Completion of the BNSF Contractor Orientation, which can be accessed at http://www.contractororientation.com/.

- Erailsafe consent form, which should be completed by the person or persons that will be overseeing the work and then the form should be returned to EMR with a "head and shoulders" digital photo. After that, EMR will put those personnel into the system, at which point, they must complete a test to receive their badge.

4.1.5 Inventory and Procurement of Equipment and Supplies

The following equipment is needed for sampling activities, and will be procured by EMR Incorporated prior to initiation of sampling activities:

- Field logbooks;
- Indelible ink pens;
- Digital camera;
- Video camera;
- Sample cassettes: 0.8 um pore, 25 millimeter (mm) diameter, mixed cellulose ester (MCE) filter cassettes;
- Sample paperwork and sample tags/labels;
- Custody seals;
- Zipper-top baggies;
- Air sampling pumps;
- Tygon tubing;
- Rotameters;
- Personal protective equipment (PPE) as required by the site Health and Safety Plan (HASP);

- High volume air pumps;
- Portable MET Station; and
- GPS device.

4.2 Sample Collection

As noted above, the goal is to collect ABS samples for rail maintenance activities during each day that they are conducted (for the on-looker trespasser receptors), and concurrently collect ABS for the pedestrian trespasser receptor who is present in the absence of rail maintenance activities. The following sections describe the sample collection procedure for each sampling event.

4.2.1 Outdoor Air Sampling

Sampling will occur over a 2-hour or 4-hour time interval, depending on the duration of maintenance activities at each location. The activities to be conducted will occur concurrently:

- Receptors 1 and 2 – onlooker trespassers during rail maintenance activities (See **Table 4-1**); and
- Receptors 3 and 4 – pedestrian trespassers walking single file remote from rail maintenance activities, but in area afforded track protection (See **Table 4-2**).

Each of the activities will be conducted consistent with the approach outlined in USEPA ERT SOP #2084, Activity-Based Air Sampling for Asbestos, with project-specific modifications (Appendix A).

Personal Air Samples

Personal air samples will be collected from the breathing zones of the event participants consistent with the approach in USEPA ERT SOP #2084, Activity-Based Air Sampling for Asbestos, with project-specific modifications, provided in Appendix A. The breathing zone can be visualized as a hemisphere approximately 6 to 9 inches around an individual's face. The flow rates for sample collection should be 5 L/min for pedestrian trespassers over a 4 hour period and 10 L/min for receptors near maintenance activities over a 2-hour period resulting in a target volume of 1,200 L. These flow rates were chosen for this sampling event in order to maximize the volume of air collected which, in turn, helps achieve the analytical sensitivities required for risk assessment evaluations. However, sampling durations and air flow rates will be optimized in the field based on site-specific considerations. Any modifications to the flow rate and sampling period will be documented in a Field Change Order (FCO) form, which is presented in Appendix C. For all asbestos sampling, an asbestos sampling train consisting of 0.8 um, 25 mm MCE filter connected to a sampling pump will be used. The top cover from the cowl extension on the sampling cassette shall be removed ("open-face") and the cassette oriented face down.

The samples will be submitted to the laboratory for analysis. If the samples are not readable by TEM after a direct preparation method, the samples may be used by applying an indirect sample preparation technique. *The laboratory must consult with BNSF/USEPA in order to select which is the most appropriate approach to follow*.

If it is necessary to relieve a participant from an activity, a relief (backup) participant will be properly suited in time to make the exchange. When the relief participant is ready, the activity participant will stop, remove the backpack or belt, pass it to the relief participant, and assist the relief participant with donning and adjusting the backpack or belt. The exchange is anticipated to take less than 60 seconds, so the sampling pumps and event time clock will not be halted during the exchange. If the exchange requires more than 60 seconds, the pump and event clock will be stopped until activity is re-initiated. This will apply to both trespasser categories (the onlooker and pedestrian trespassers).

Pump Fault and Flow-Rate Error Procedures

For the onlooker and pedestrian trespassers, pump flow rates will be verified at 60 minute intervals or when participants are relieved from an activity by a backup participant, whichever occurs sooner. If at any time the observed flow rates deviate more than ±10 percent of the target rate, the sampling pump should be re-calibrated. If at any time, an air sampling pump is found to have faulted or the observed flow rates are 30 percent below or 50 percent above the target rate, **Figure 4-1** should be consulted to determine the appropriate action. The time elapsed from the start of the activity until the fault/flow observation will be used to determine the appropriate action according to **Figure 4-1**.

To calculate the percentage of an observed flow to the target flow, the following formula is used:

$$X\% = \frac{Observed\ Flow\ Rate\ (L/min)}{Target\ Flow\ Rate\ (L/min)} \cdot 100$$

Figure 4-2 illustrates the number of grid openings that will require analysis to achieve the target sensitivity (0.001 cc^{-1}) (see Section 3.7.2) when flow rate is 10 L/min, the area of one grid opening is 0.01 mm^2, and there is a pump fault and the collection time is less than two hours.

MET Station Data

A portable MET station will be deployed to record parameters representative of each sampling location. The following parameters will be recorded every 60 seconds during each event: wind speed, wind direction, relative humidity, temperature, and barometric pressure. The meteorological station should be placed close enough to the activities so the observations of the MET station reflect the conditions of the activity area.

In addition, during days when ABS activities are occurring, MET data will be downloaded from the local NOAA station, LBBM8. The following parameters are recorded hourly at this station:

- Temperature (degrees Fahrenheit [°F]);
- Dew point (°F);
- Relative humidity (percent);
- Wind speed (miles per hour [mph]);
- Wind gust (mph);
- Wind direction;
- Solar radiation (watts per square meter per hour [watts/m^2 per hour]); and
- Precipitation (inches).

Copies of all MET station data will be provided to USEPA and BNSF within one week after collection. Electronic copies have been determined to be suitable by USEPA.

Stationary Air Monitors

According to USEPA's SOP # 2084 regarding Activity-Based Air Sampling for Asbestos (USEPA 2007c), stationary air monitors are defined as samples collected upwind, downwind or crosswind of a specific activity. When selecting areas for stationary air monitors, consideration should be given to the potential off-site migration of contaminants and possible exposure to off-site residents. A minimum of two stationary monitors will be placed upwind and downwind of the ABS sampling area, with a maximum of four stationary monitors placed around the perimeter of the sampling area. Air sampling should be conducted to document the airborne concentration of asbestos at the ROW perimeter during activities. Perimeter air monitoring will be conducted to:

- Document air quality during ABS and establish background or upwind levels of asbestos during maintenance activities;
- Monitor and document air quality during site activities near sensitive receptors; and
- Provide risk management information and address public confidence.

High volume air pumps will be calibrated to collect 10 L/min for on-site and off-site air samples through the filter. The flow rate will allow a target volume of 2,400 L over a 4-hour sampling event. Lower volume air samples will be collected concurrently at the perimeter sampling locations using personal sampling pumps, if loading is an issue. These pumps will be utilized in the same manner with the same media at a flow rate of 5 L/min in order to collect a sample volume of approximately 1,200 L over a 4-hour sampling event. Collocated samples are collected to sample a high and low volume of air to increase the likelihood of at least one of the two samples being readable using the direct analytical method (ISO 10312) (USEPA 2007c). Sampling durations and air flow rates will be optimized in the field based on site-specific considerations; any changes will also take into consideration the target analytical sensitivity.

4.2.2 Outdoor Soil Sampling

The area where ABS activities are performed will be delineated with stakes, pin flags, or equivalent visual markers. Up to fifteen (15) discrete soil grab samples will be collected near rail maintenance activities and in track-protected areas of the ROW away from rail maintenance activities, as presented in **Tables 3-1 and 4-3.** The number of soil samples may vary from each ABS maintenance area due to the length of rail maintenance activities and the presence of exposed soil near the track(s). In rail maintenance areas where there is minimal exposed soil near the track(s), less than 15 samples could be collected. Likewise, if the soil maintenance track length is less than 1,000 feet, less than 15 samples could be collected; however, the soil samples will be collected so that the entire ABS area is represented. Samples will be relinquished to onsite CDM personnel for sample preparation and subsequent submission to the laboratory.

Discrete soil grab samples will be collected and homogenized in accordance with the Site-Specific SOP for Soil Sample Collection (CDM-LIBBY-05, Revision 2) provided in Appendix A, with the exception that the soil will not be wetted with water before collection. Prior to homogenizing the soil samples, field observations will be made as described in the Site-Specific SOP for Semi-Quantitative Visual Estimation of Vermiculite in Soil (CDM-Libby-06rv1), presented in Appendix A. Samples will be relinquished to onsite CDM personnel for sample preparation, electronic chain of custody (eCOC) creation and subsequent submission to the laboratory for PLM-VE analysis.

In order to ensure that sufficient sample is available for potential future investigations, the mass of the discrete soil grab samples must be no less than 0.5 to 1 kilograms (kg).

A sketch of the outdoor area will also be prepared to indicate the approximate locations and size of the ABS activity area. The sketch should indicate the soil condition at the ABS location, including the extent of vegetative and other cover and any other important visual features. The sketch should also indicate the approximate location and level of any visible vermiculite in the area, and the approximate boundary of the area selected for the ABS area(s). This should be done in accordance with the Site-Specific SOP for Semi-Quantitative Visual Estimation of Vermiculite in Soil (CDM-LIBBY-06, Revision 1) with the following modifications:

- Areas adjacent to the maintenance activity will be divided into zones and inspected for visual vermiculite or presence of LA. Zone size will be determined in the field.

- Semi-quantitative estimates of vermiculite observed during sample collection will be recorded on FSDS and not on the Visual Vermiculite Estimation Form.

Outdoor soil sampling and observations shall occur close to the time that the outdoor air samples are collected, ideally prior to commencement of the rail maintenance activity. If these cannot be carried out in sequence (within the same 24-hour period), the field team should note this in the field logbook.

Soil moisture will be estimated for each ABS activity area by the hand appearance method that provides results in percent of field capacity. This is performed by firmly squeezing a handful of soil and comparing the results to the table below. For each ABS area, soil used for this evaluation should be collected from the center of the area and be from 0 to 2 inches below ground surface.

Field Test for Moisture Content – Interpretation Table			
Percent Soil Moisture Deficiency	Moderately coarse texture	Medium texture	Fine and very fine texture
0 (field capacity)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.		
0 to 25	Forms weak ball, breaks easily when bounced in hand.*	Forms ball, very pliable, slicks readily.*	Easily ribbons out between thumb and forefinger.*
25 to 50	Will form ball, but falls apart when bounced in hand.*	Forms ball, slicks under pressure.*	Forms ball, will ribbon out between thumb and forefinger.*
50 to 75	Appears dry, will not form ball with pressure.*	Crumbly, holds together from pressure.*	Somewhat pliable, will ball under pressure.*
75 to 100	Dry, loose, flows through fingers.	Powdery, crumbles easily.	Hard, difficult to break into powder.
*Squeeze a handful of soil firmly to make ball test.			

In addition to estimating soil moisture content in the field, 10 percent of soil samples submitted for asbestos analysis will also be analyzed for moisture content using American Society for Testing and Materials (ASTM) Method D2216-05: *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

In addition, soil texture will be determined as prescribed by United States Department of Agriculture, Natural Resources Conservation Service techniques (see modification to ERT SOP #2084 in Appendix A). The result will be recorded in the field logbook.

4.3 General Processes

4.3.1 Equipment Decontamination

Decontamination of air sampling pumps and soil sampling equipment will be conducted as described in Section 3.0 of the Project-Specific Procedures, as presented in Appendix A. Equipment used during activities will be decontaminated after each use as described in CDM-LIBBY-05, Site-Specific SOP for Soil Sample Collection (see Appendix A), and the HASP (see Appendix B).

4.3.2 Sample Labeling and Identification

Sample index identification numbers will identify the samples collected during this study by having the following format:

RR-#####

BA-#####

where:

RR	=	Soil sample collected from OU6 ROW
BA	=	Activity-based air sample collected from OU6 ROW
#####	=	A sequential number starting with 00001; sample identification information will be documented in the field logbook

4.3.3 Videotape Documentation

A videotape will be prepared to document a representative example of each activity including any special conditions or circumstances that arose during the activity, following Section 6 of the OU6 Project-Specific Procedures, and Project-Specific Procedure – 5: Photographic Documentation of Field Activities, as presented in Appendix A. File names will be in the format:

RRABS_(T, or P)_MP####_MMDDYY, where:

RRABS	=	Railroad Activity Based Sampling
T	=	Trespasser during rail maintenance activities
P	=	Pedestrian in absence of rail maintenance activities
MP	=	Closest Mile Post
####	=	Mile Post number
MMDDYY	=	Month day year

All photographic documentation will be maintained in project files.

4.3.4 Field Logbooks

Field logbooks will be completed and managed as described in Section 4.0 of the Project-Specific Procedures, as presented in Appendix A. The Project-Specific Procedure - 4: Field Logbook Content and Control, including project-specific modification is also provided in Appendix A. Copies of all logbook entries will be provided to USEPA and BNSF within one month of collection.

4.3.5 Field Sample Data Sheets

Field Sample Data Sheets (FSDSs) will be completed and managed as described in Section 5.0 of the Project-Specific Procedures, as presented in Appendix A. Appendix D contains copies of the specific FSDSs that will be used to record information for samples collected during the activities described in this SAP. Copies of FSDSs will be provided to USEPA and BNSF within one month of collection.

4.3.6 Photographic Documentation

Photographs will be collected, documented, and managed as described in Section 6.0 of the Project-Specific Procedures, as presented in Appendix A. The Project-Specific Procedure - 5: Photographic Documentation of Field Activities is also provided in Appendix A. Photographs will be used to document areas where outdoor activities are conducted. Photographs of each event will be compiled into one file, and file names will be in the format:

RRABS_(T, or P)_MP####_MMDDYY, where:

RRABS	=	Railroad Activity Based Sampling
T	=	Trespasser during rail maintenance activities
P	=	Pedestrian in absence of rail maintenance activities
MP	=	Closest Mile Post
####	=	Mile Post number
MMDDY	=	Month day year

4.3.7 GPS Point Collection

GPS location coordinates will be collected as described in Section 7.0 of the Project-Specific Procedures and in accordance with CDM-LIBBY-09, which are both provided in Appendix A. As related to the activities described in the SAP, one set of coordinates will be collected from the approximate ROW MP boundaries for each activity area. These coordinates will also represent the GPS coordinates associated with soil samples collected from the area. GPS coordinates will also be collected for the MET station.

4.3.8 Field Equipment Maintenance

Air sampling pump calibrations will be conducted and documented as described in Section 8.0 of the Project-Specific Procedures, as presented in Appendix A. Field equipment maintenance will be conducted and documented as described in Section 9.0 of the Project-Specific Procedures and in accordance with the Project-Specific Procedure - 6: Control of Measurement and Test Equipment, which are both provided in Appendix A.

4.3.9 Handling IDW

IDW will be managed as described in Section 10.0 of the Project-Specific Procedures, as presented in Appendix A. The Project-Specific Procedure - 3: Guide to Handling of IDW is also provided in Appendix A.

4.3.10 Field Sample Custody and Documentation

Field Sample Custody and Documentation will follow the requirements described in Section 11.0 of the Project-Specific Procedures, as presented in Appendix A. The Project-Specific Procedure - 1: Sample Custody is also provided in Appendix A. Copies of all eCOC forms will be provided to USEPA within one month of collection.

4.3.11 Sample Packaging and Shipping

Sample packaging and shipping will follow the requirements described in Section 12.0 of the Project-Specific Procedures, which is presented in Appendix A. The Project-Specific Procedure - 2: Packaging and Shipping of Environmental Samples, including a project-specific modification is also provided in Appendix A.

4.3.12 Modification Forms

All deviations will be documented and recorded according to the requirements described in Section 13.0 of the Project-Specific Procedures, as presented in Appendix A. A copy of the modification form is provided in Appendix E.

4.4 Quality Assurance/Quality Control (QA/QC) Activities

The QA/QC actions required for each process described in this SAP will follow the requirements described in the Section 15.0 of the Project-Specific Procedures, which is provided in Appendix A.

Collection of QA/QC Field Samples

QA/QC samples will be collected according to the procedures described in the Project-Specific Procedures. **Table 4-4** summarizes the QA/QC sample collection and analysis frequencies for the outdoor ABS investigation.

5.0 Laboratory Analysis and Requirements

All laboratories that analyze samples collected as part of this project must participate in and have satisfied the certification requirements in the last two proficiency examinations from the National Institute of Standards and Technology/National Voluntary Laboratory Accreditation Program (NVLAP). The laboratory must also analyze performance evaluation samples when requested. These analyses must be performed to confirm laboratory capabilities before any samples are submitted to the laboratory and may be subsequently submitted at regular intervals. In addition, the laboratory must participate in the laboratory training program developed by the Libby laboratory team. Appendix F provides the Analytical Requirements Summary Form.

5.1 Analytical Methods

5.1.1 Air

All outdoor air samples will be submitted to a subcontracted laboratory for analysis using the International Organization for Standardization (ISO) TEM method 10312, also known as ISO 10312:1995(E) (CDM 2003a), with all applicable project specific modifications (CDM 2003b). These and other project-specific modifications are included in Appendix A. All asbestos structures (including not only Libby amphibole but all other asbestos types as well) that have appropriate diffraction patterns and EDS spectra, and having a length ≥ 0.5 um and an aspect ratio ≥ 3:1 will be recorded on the Libby site-specific laboratory data sheets and electronic deliverables.

The target analytical sensitivity for all ABS air samples is 0.001 cc^{-1} (see Section 3.7.2). Field blanks and lot blanks, will be analyzed by counting an area of 0.1 mm^2 (K. Hernandez, USEPA, personal communication).

5.1.1.1 Stopping Rules

For field samples, the initial stopping rules are as follows:

Count the sample until one of the following is achieved:

- The target analytical sensitivity is achieved
- 50 LA structures are observed
- An area of 0.5 mm^2 of filter has been examined

When one of these goals is achieved, complete the final grid opening and stop. These stopping rules may be revised as data become available on the levels of LA and dust that are collected in the field samples.

For field blanks and lot blanks, examine a filter area of 0.1 mm^2 and stop.

5.1.1.2 Quality Control (QC) Samples

As described in the latest version of laboratory modification LB-000029, the frequency for laboratory-based quality control (QC) samples for TEM analysis is:

- Lab blank = 4 percent
- Recount same = 1 percent
- Recount different = 2.5 percent
- Re-preparation = 1 percent
- Verified analysis = 1 percent

- Inter-laboratory = 0.5 percent

5.1.2 Soil

All soil samples collected as part of this effort will be analyzed for asbestos by PLM-VE in accord with SOPs SRC-LIBBY-01, Revision 2 and SRC-LIBBY-03, Revision 1 (SRC-LIBBY-03, Revision 2 is pending).

Laboratory QC will follow Libby Asbestos Project requirements as documented in Section 14.0 of.the Project-Specific Procedures sections presented in Appendix A.

A random subset of about 10 percent of all soil samples collected as part of this outdoor ABS effort will be analyzed for soil moisture content in accord with ASTM D2216-05: Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil.

5.1.3 Sample Archival

All air samples will be submitted to a project laboratory for analysis. Once analyzed, all samples will be stored (archived) at the laboratory under COC until further notice.

Aliquots of soil samples not sent for immediate analysis will be archived at the Soil Preparation Laboratory in accord with standard practice, as detailed in the latest version of the Close Support Facility Soil Preparation Plan.

5.2 Holding Times

No preservation requirements or holding times are established for air or soil samples collected for asbestos analysis.

5.3 Laboratory Custody Procedures and Documentation

Laboratory custody procedures and documentation will be completed as required by the specifications detailed in Section 16.0 of the Project-Specific Procedures, as presented in Appendix A.

5.4 Documentation and Records

Laboratory documentation and records will be completed as required by the specifications detailed in Section 17.0 of the Project-Specific Procedures, as presented in Appendix A.

5.5 Data Management

Sample result data will be delivered to BNSF, USEPA, the Volpe Center, and CDM's Cambridge office both in hard copy and as an electronic data deliverable (EDD) in the most recent project-specific format. Electronic copies of all project deliverables, including graphics, will be filed by project number. Electronic files will be routinely backed up and archived according to individual laboratory processes.

Both BNSF and USEPA will maintain a project database for the information collected under this SAP.

All results, field data sheet information, and survey forms will be maintained in the Libby project database managed by the Volpe Center under the oversight of the Volpe Center database management team. BNSF will maintain a database for the work conducted for OU6.

6.0 Assessment and Oversight

Assessments and oversight reports to management are necessary to ensure that procedures are followed as required and that deviations from procedures are documented. These reports also serve to keep management current on field activities. Assessment, oversight reports, and response actions are discussed below.

6.1 Assessments

Performance assessments are quantitative checks on the quality of a measurement system and are appropriate to analytical work. Performance assessments for the laboratories may be accomplished by submitting reference material as blind reference (or performance evaluation) samples. These assessment samples have known concentrations of LA that are submitted to the laboratories without informing the laboratories that they are performance evaluation samples. Laboratory audits may be conducted upon request from the USEPA Team Leader (TL).

System assessments are qualitative reviews of different aspects of project work to check on the use of appropriate QC measures and the functioning of the quality assurance (QA) system. Project assessments will be performed under the direction of the contractor QA managers.

6.2 Response Actions

Response actions will be implemented on a case-by-case basis to correct quality problems. Minor response actions taken in the field to immediately correct a quality problem will be documented in the applicable field logbook and a verbal report will be provided to the BNSF Project Manager (PM). For verbal reports, the BNSF PM will complete a communication log to document the response actions were relayed to him/her. Major response actions taken in the field will be approved by the BNSF PM and USEPA TL, prior to implementation of the change. Major response actions are those that may affect the quality or objective of the investigation. Quality problems that cannot be corrected quickly through routine procedures may require implementation of a corrective action request.

All formal response actions will be submitted to either BNSF's contractor's QA manager and/or project QA coordinator for review and issuance. The PM or local QA coordinator will notify the QA manager when quality problems arise that may require a formal response action.

In addition, when modifications to this specific SAP are required, either for field or laboratory activities, a Libby FCO Form (Appendix C) and a Libby Asbestos Project Record of Modification Form (Appendix E) must be completed.

6.3 Reports to Management

QA reports will be provided to management whenever quality problems are encountered. Field staff will note any quality problems on field data sheets, or in field logbooks. BNSF will inform the USEPA's project QA coordinator upon encountering quality issues that cannot be immediately corrected. Weekly reports and change request forms are not required for this work assignment. Monthly QA reports will be submitted to USEPA's QA manager by the BNSF QA coordinator.

Topics to be summarized regularly may include but not be limited to:

- Document technical and QA reviews that have been conducted;
- Activities and general program status;
- Project meetings;

- Corrective action activities;
- Any unresolved problem; and
- Any significant QA/QC problems not included above.

7.0 Data Validation and Usability

Laboratory results will be reviewed for compliance with project objectives. Data validation and evaluation are discussed in Sections 7.1 and 7.2, respectively.

7.1 Data Review, Validation, and Verification Requirements

Data review, validation, and verification will be performed for important investigative samples as described in Section 18.0 of the OU6 QAPP, provided in Appendix A. Data validation, review, and verifications must be performed on sample results before distribution to the public for review. Requirements for the frequency of data review are initially set at 10 percent. This initial rate may be revised as initial samples are analyzed and results evaluated.

Data validation consists of examining the sample data package(s) against pre-determined standardized requirements. The validator may examine, as appropriate, the reported results, QC summaries, case narratives, COC information, raw data, initial and continuing instrument calibration, and other reported information to determine the accuracy and completeness of the data package. During this process, the validator will verify that the analytical methodologies were followed and QC requirements were met. The validator may recalculate selected analytical results to verify the accuracy of the reported information. Analytical results will then be qualified as necessary.

Data verification includes checking that results have been transferred correctly from FSDS forms and laboratory bench sheets to the laboratory report and to the EDD. Data verification for this project is performed in part as a function of built-in quality control checks in the Libby project database when data is uploaded, and is also performed manually in accordance with SOP EPA-LIBBY-09. However, the sample coordinator will notify the laboratories and the project database manager of any discrepancies found during data usage.

7.2 Reconciliation with Data Quality Objectives

Once data have been generated, USEPA and BNSF will evaluate the data to determine if DQOs were achieved. This achievement will be discussed in a report to be submitted to USEPA, including the data and any deviations to this SAP. It is currently envisioned that the data will be submitted as part of a Preliminary Conceptual Site Model Report, which will be used to collect and evaluate existing data, develop a conceptual site model for OU6, and identify data gaps that will be addressed during the RI/FS process. BNSF will maintain a database for the work conducted at OU6. Sample data will also be maintained in the USEPA project database**.** Laboratory QC sample data will be stored in hard and electronic copy.

8.0 Project Schedule

It is anticipated that the upcoming rail maintenance activities and associated ABS sampling will be conducted from September 17 to 23**,** 2008. It is anticipated that results from this round of sampling will be available for tabulation in late October 2008.

9.0 References

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Tables

Table 3-1 Description of Rail Maintenance Activities For Public Receptors
Rail Maintenance Public Receptor Activity-Based Sampling and Analysis Plan
Operable Unit 6, Libby, Montana Superfund Site - September 2008

MP: 1312, 1314	General Maintenance Activity: Curve Replacement [a]				Onlooker Trespasser Sampling Activity				Walking Trespasser Sampling Activity			
Time	**Description**	**Soil Disturbance Potential**	**Duration (hrs)**	**# Stationary (Perimeter) Monitors**	**# ABS Samplers**	**Approx. ABS Duration (hrs)**	**# Soil Samples**	**ABS and Soil Locations**	**# ABS Samplers**	**ABS Duration (hrs)**	**# Soil Samples**	**ABS and Soil Locations**
7:00 AM	Safety Meeting	Low	0.5	NA	NA				NA			
7:30 AM	Track Material Inspection	Low	0.5	NA	NA				NA			
8:00 AM	Steel Gang: Rail Removal	Medium	1	4	NA (area is monitored for trespassers during rail replacement activities)				2 [d]	4	15 [b] [c]	ahead of work area
8:30 AM												
9:00 AM	Steel Gang: Rail Replacement		1									
9:30 AM												
10:00 AM	Surface Gang: Tamper Ballast	Medium	1		2	2	15 [b] [c]	near work area				
10:30 AM												
11:00 AM	Surface Gang: Regulate Track	High	1									
11:30 AM												
12:00 PM	Lunch and transport to new work site [c]											
12:30 PM												
1:00 PM	Steel Gang: Rail Removal	Medium	1	4	NA (area is monitored for trespassers during rail replacement activities)				2 [d]	4	15 [b] [c]	ahead of work area
1:30 PM												
2:00 PM	Steel Gang: Rail Replacement		1									
2:30 PM												
3:00 PM	Surface Gang: Tamper Ballast	Medium	1		2	2	15 [b] [c]	near work area				
3:30 PM												
4:00 PM	Surface Gang: Regulate Track	High	1									
4:30 PM												
5:00 PM	Inspection of Finished Trackwork	Low	1	NA	NA				NA			
5:30 PM												

Notes:
NA = not applicable
Typical track work length = 1/4 to 1/2 mile
[a] A field log of maintenance activities, including schedules and specific activities will be maintained by EMR field supervisor (or similar). GPS locators may help specify soil sampling locations.
[b] A field test for moisture content of soil should be conducted using soil collected from center of activity area from 0-2 inches bgs.
[c] Each sample collected for PLM-VE composite is assigned a level of none, low, medium or high in the field. See SOP in Appendix A for details.
[d] One walker will lead and the other walker will trail behind. Walking will occur on both ballast and soils.

**Table 4-1 Summary of Onsite Onlooker Trespasser ABS Design
Rail Maintenance Public Receptor Activity-Based Sampling and Analysis Plan
Operable Unit 6, Libby, Montana Superfund Site - September 2008**

Item	Description
Conceptual Model	See Table 3-1
Representativeness	Represents personal air when trespassers are watching rail maintenance activities
Exposure parameters assumed in calculation of target sensitivity	ET = 2 hrs/event Flow rate = 10 L/min Volume Air Sampled = 1,200 L (1,200,000 cc)
Analytical Requirements	Method = ISO 10312 with all applicable lab mods Sensitivity = 0.001 cc^{-1} Stopping rules: a) Target S achieved (approx 32 GO/0.32 mm^2 expected) b) Max LA structures observed = 50 c) An area of 0.5 mm2 of filter has been examined
Initial number of samples (a)	1 per trespasser x 2 trespassers / event x 2 events/day = 4

(a) The number of samples needed for risk assessment and risk management depends on the inter-sample variability and how close the data are to a decision threshold. This number of samples is expected to provide sufficient information to determine if additional samples are needed, and if so, how many.

GO - Grid Opening
LA - Libby Amphibole.

Table 4-2 Summary of Onsite Pedestrian Trespasser ABS Design
Rail Maintenance Public Receptor Activity-Based Sampling and Analysis Plan
Operable Unit 6, Libby, Montana Superfund Site - September 2008

Item	Description
Conceptual Model	See Table 3-1
Representativeness	Represents personal air when trespassers are walking along the ROW
Exposure parameters assumed in calculation of target sensitivity	ET = 4 hrs/event Flow rate = 5 L/min Volume Air Sampled = 1,200 L (1,200,000 cc)
Analytical Requirements	Method = ISO 10312 with all applicable lab mods Sensitivity = 0.001 cc^{-1} Stopping rules: a) Target S achieved (approx 32 GO/0.32 mm^2 expected) b) Max LA structures observed = 50 c) An area of 0.5 mm2 of filter has been examined
Initial number of samples (a)	1 per trespasser x 2 trespassers / event x 2 events/day = 4

(a) The number of samples needed for risk assessment and risk management depends on the inter-sample variability and how close the data are to a decision threshold. This number of samples is expected to provide sufficient information to determine if additional samples are needed, and if so, how many.

GO - Grid Opening
LA - Libby Amphibole.

Table 4-3 Soil Sampling Details For Public Receptors
Rail Maintenance Public Receptor Activity-Based Sampling and Analysis Plan
Operable Unit 6, Libby, Montana Superfund Site - September 2008

Specific Use Area	Characteristics	Anticipated Activities	Soil Sample Area or Distance	Proposed # Discrete Soil Grab Samples
Mainline Accessible	Portions of mainline within 1 mile of grade crossing, or close to parallel road. Portions of mainline accessible from BNSF access road. Train traffic at constant speed.	Monthly or more Infrequent railroad maintenance and daily inspection, Trespassing	1 mile stretch	15
Mainline Inaccessible	Portions of mainline more than 1 mile from grade crossing, or close to parallel road. No BNSF access roads. Train traffic at constant speed.	Monthly or more infrequent railroad maintenance and daily inspection	1 mile stretch	15
Sidings	Mainline and passing track present. BNSF access roads usually present the entire length of siding	Weekly railroad maintenance and daily inspection. Trespassing more likely due to good access.	50,000 ft^2 (or less)	15
Siding Approaches	Would have the same characteristics as mainline, with the exception of variable train speeds.	Railroad maintenance and inspection, Trespassing	50,000 ft^2 (or less)	15
Yards	Multiple track facilities located near a population center. Uncontrolled access by general public. Highly variable train speeds and switching activities.	Railroad maintenance and TE employees on a daily basis. Weekly to monthly inspection. Frequent trespassing.	NA	NA
BNSF Access Roads	Dirt/ballast roads that allow access to BNSF ROW from public roads. Security measures vary from locked gates to trespassing signs.	Railroad maintenance and TE employees on a daily to weekly basis. Frequent trespassing.	10,000 ft^2 (or less) where access road crosses ROW	15

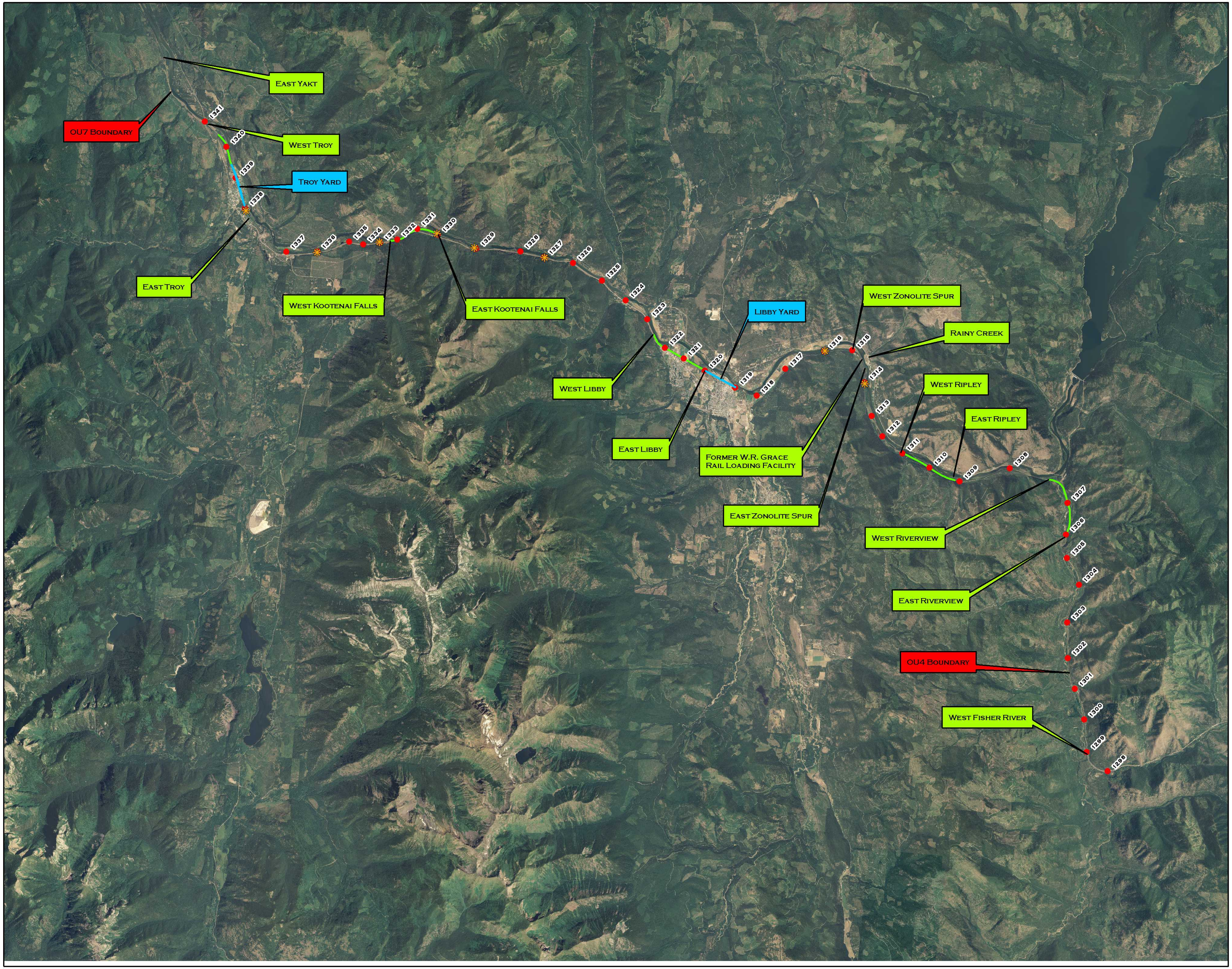
Notes:
NA = not applicable

Table 4-4 Summary of Field QC Samples by Medium
Rail Maintenance Public Receptor Activity-Based Sampling and Analysis Plar
Operable Unit 6, Libby, Montana Superfund Site - September 2008

Media	Sample Type	Minimum Collection Frequency		Minimum Analysis Frequency	Acceptance Criteria	Acceptance Criteria Failure Action
Air	Lot Blank	1 per 50 cassettes	2%	1 per 50 cassettes	ND for all asbestos	Rejection of all cassettes in lot
	Field Blank	1 per day		10% of total collected per week	ND for all asbestos fibers	Analysis of additional field blanks to determine source of potential cross-contamination, qualification of sample results, evaluation of field sample handling procedures
	Co-located	1 per 20 samples	5%	100%	<5% statistically significant difference	Evaluation of sample collection techniques
Soil	Field Duplicate	1 per 20 samples	5%	100%	Not applicable	
	Performance Evaluation	4 total samples		100%	<10% strongly discordant	Examination of analytical lab procedures

Notes:
QC - quality control
ND - nondetect
COC - chain of custody

Figures



N
W E
S

Figure 1-1
Scheduled Rail Maintenance
Work Sites

BNSF Kootenai River Sub

Legend

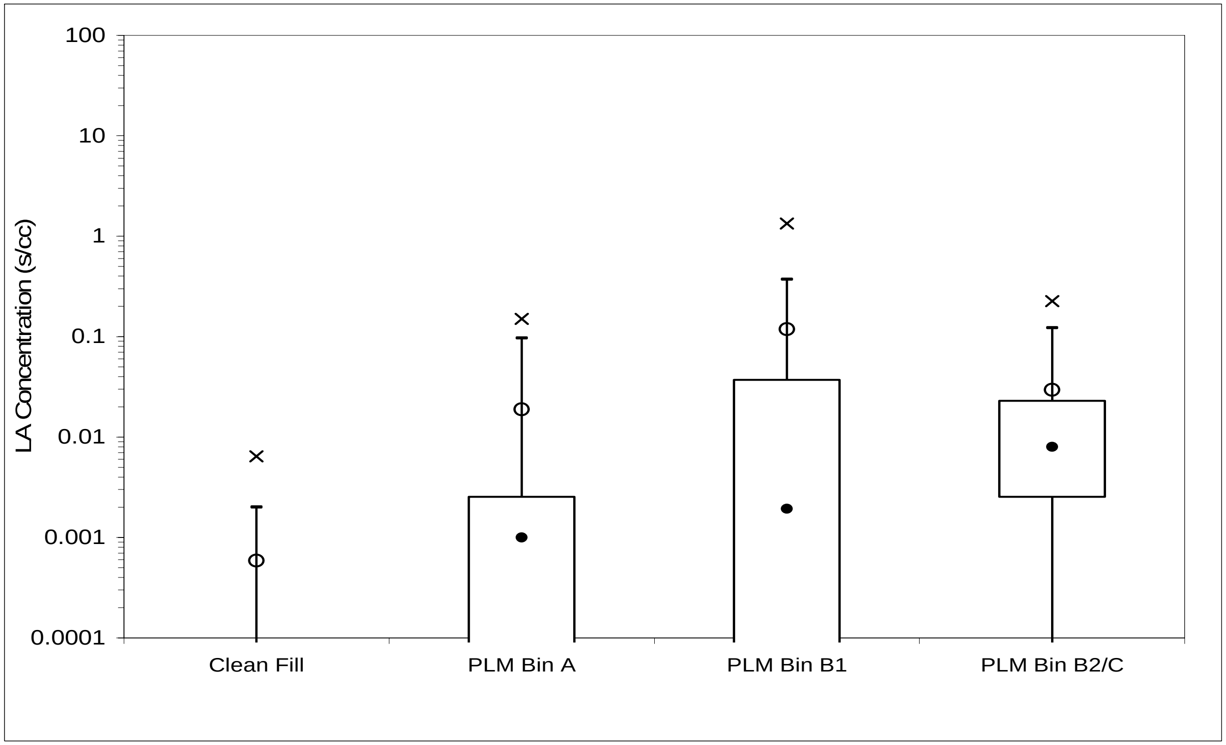
- Steel Gang Work Sites
- BNSF Yard
- Approximate Milepost Locations
- Rail Sidings

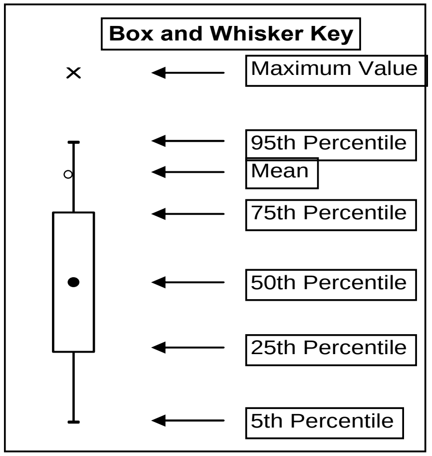
0 7,500 15,000 30,000
Scale In Feet

0 1 2 4
Scale In Miles

EMR
INCORPORATED

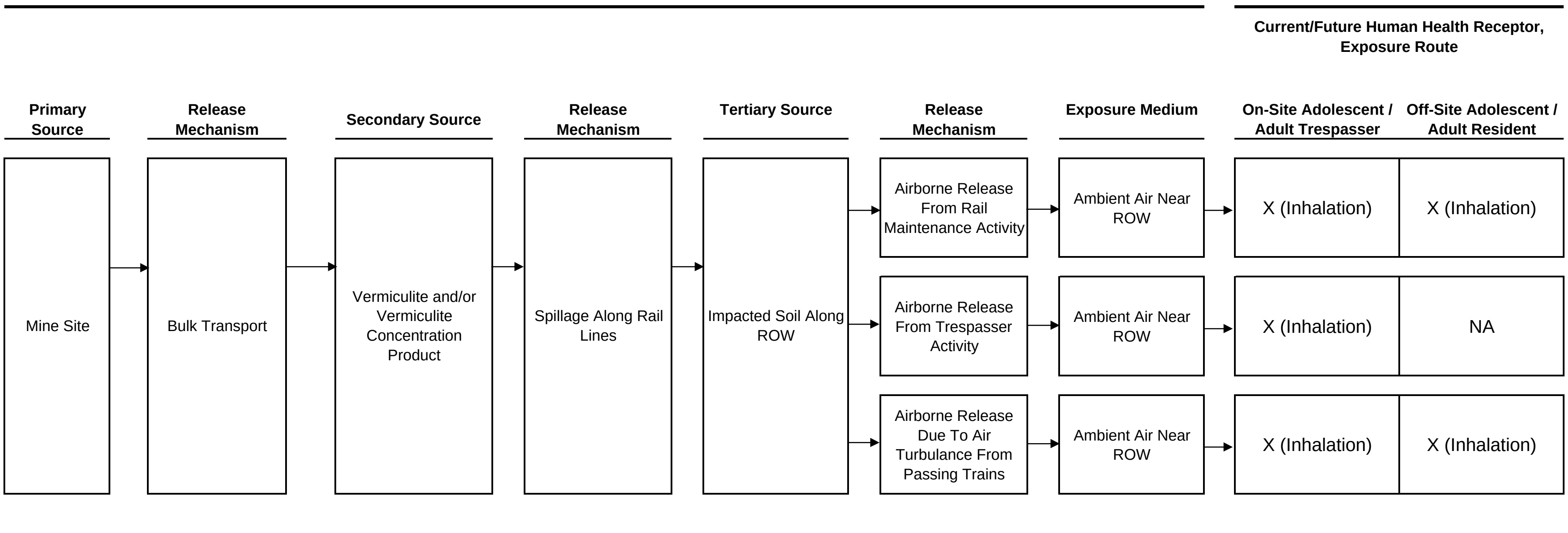
Figure 2-1 (From USEPA 2007a) Total LA Levels In Personal ABS Air Samples Near Soil Disturbances
Rail Maintenance Activity-Based Sampling and Analysis Plan
Operable Unit 6, Libby, Montana Superfund Site – September 10, 2008





Metric	Soil Category			
	Clean Fill	PLM Bin A	PLM Bin B1	PLM Bin B2/C
N	21	10	21	13
DF	24%	60%	67%	77%
Max	0.006	0.150	1.34	0.23
95%	0.002	0.097	0.374	0.123
75%	0.000	0.003	0.037	0.023
50%	0.000	0.001	0.002	0.008
25%	0.000	0.000	0.000	0.003
5%	0.000	0.000	0.000	0.000
Mean	0.00059	0.019	0.12	0.029

Figure 3-1 Refined Conceptual Site Model For Public Receptors
Rail Maintenance Public Receptor Activity-Based Sampling and Analysis Plan
Operable Unit 6, Libby, Montana Superfund Site, September 2008



Legend:

X — Potentially Complete and Significant Exposure Pathway - to be quantitatively evaluated in the risk assessment

ROW = BNSF Right of Way

Figure 3-2 (From USEPA 2007a) Example Uncertainty in the Mean of a Lognormal Data Set with σ = 2.0
Rail Maintenance Activity-Based Sampling and Analysis Plan
Operable Unit 6, Libby, Montana Superfund Site – September 10, 2008

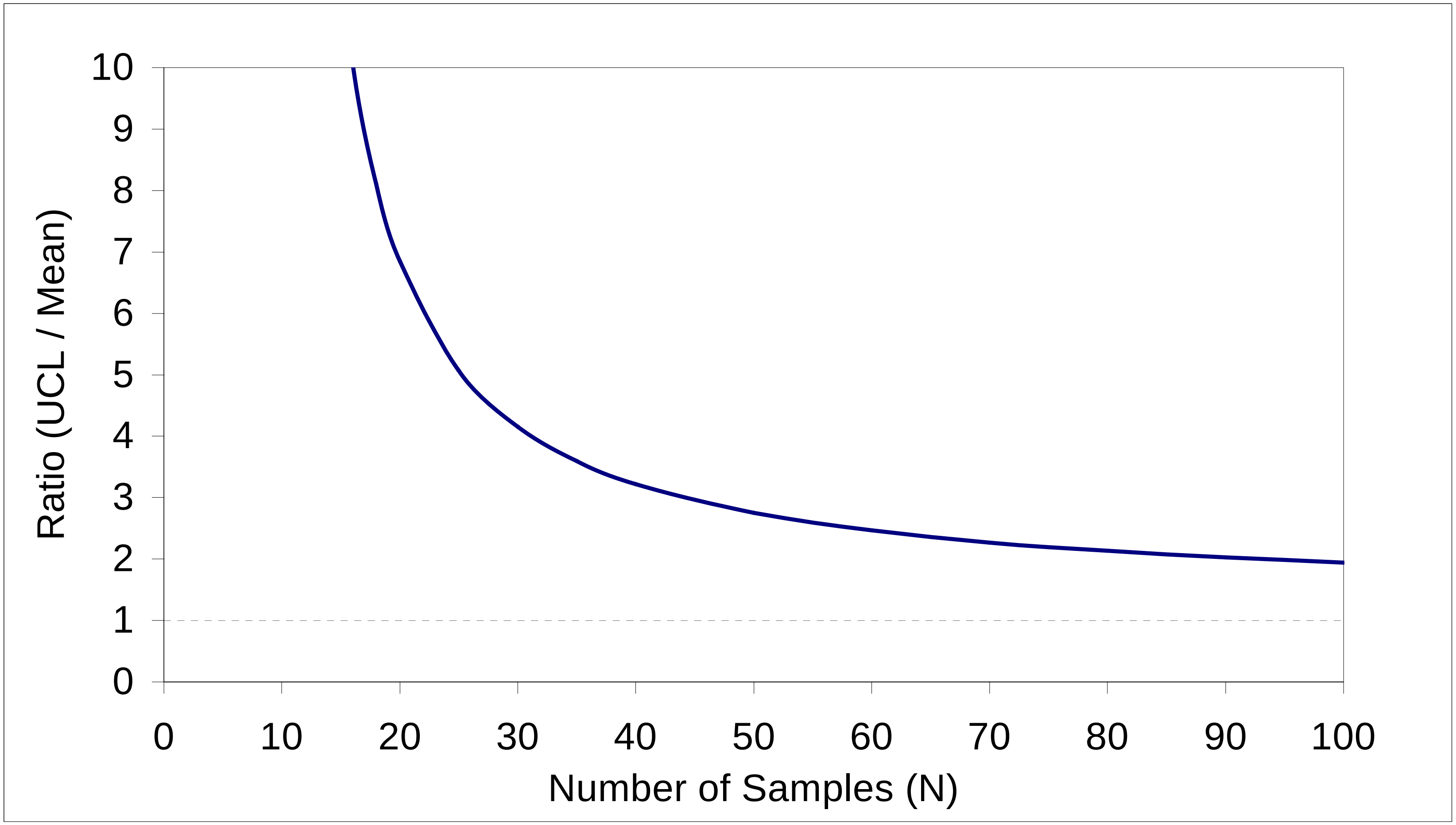


Figure 4-1 (From USEPA 2007a) Procedures for Pump Fault and Flow-Rate Errors
Rail Maintenance Activity-Based Sampling and Analysis Plan
Operable Unit 6, Libby, Montana Superfund Site – September 10, 2008

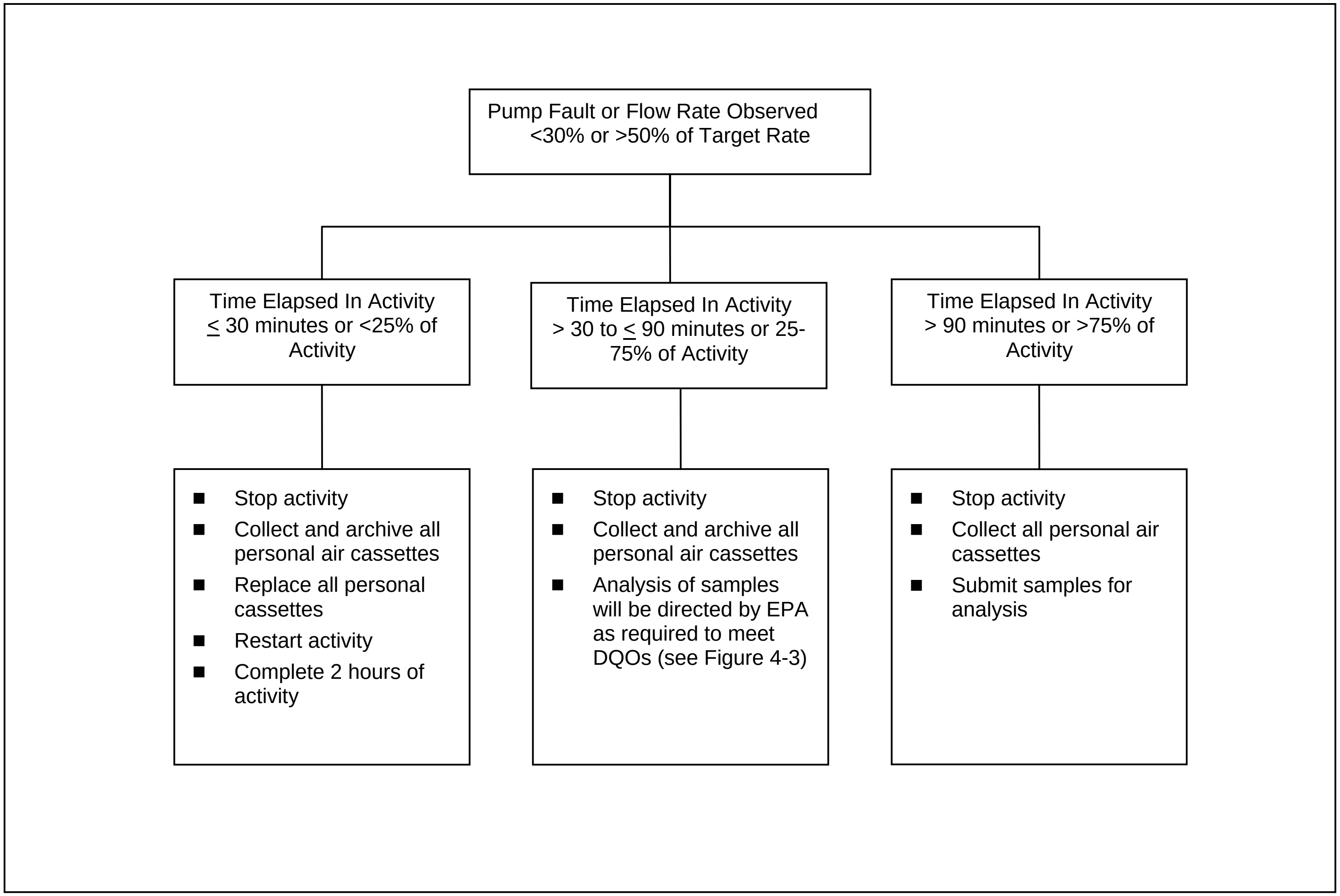
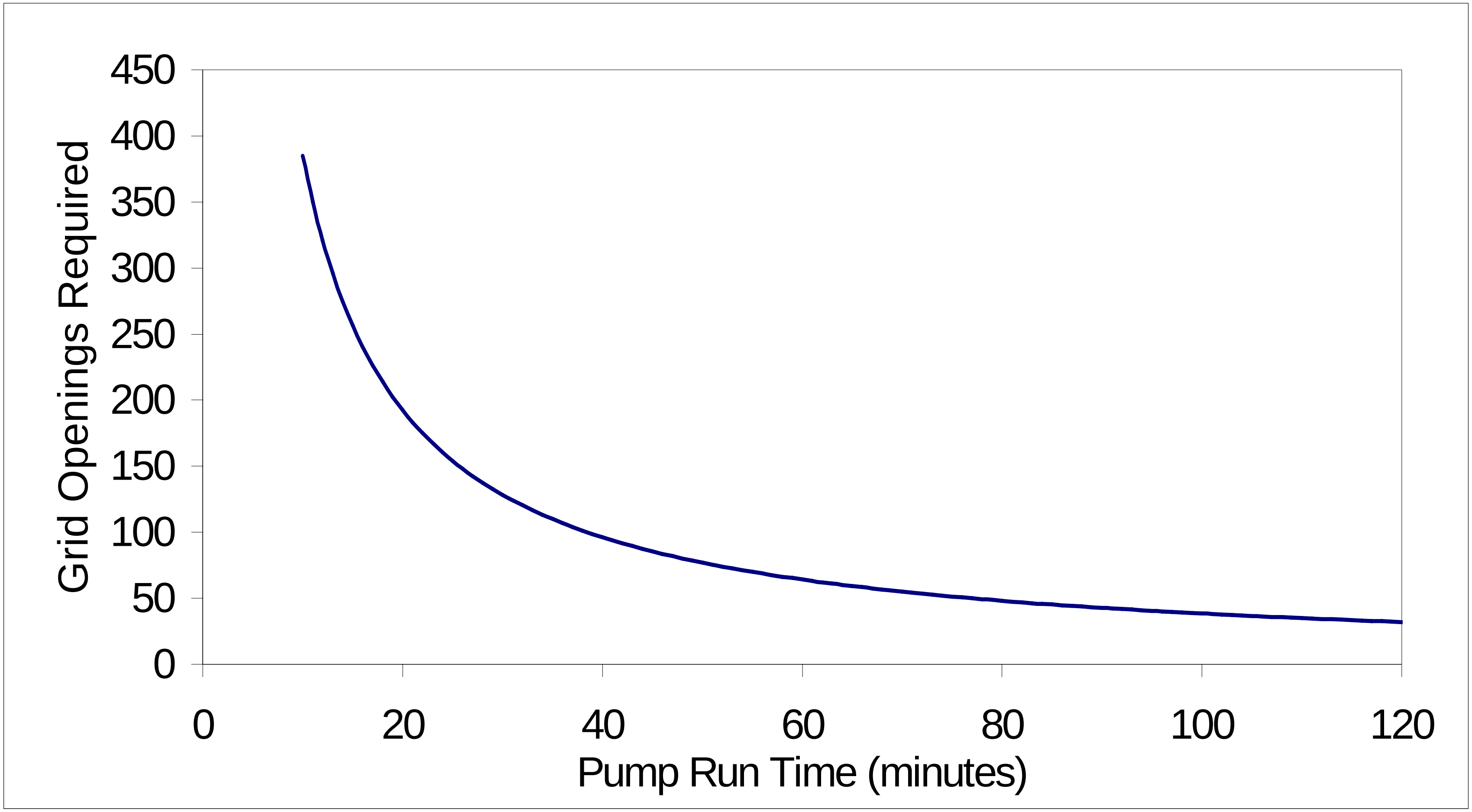


Figure 4-2 (From USEPA 2007a) Effect of Pump Time of Grid Openings Required
Rail Maintenance Activity-Based Sampling and Analysis Plan
Operable Unit 6, Libby, Montana Superfund Site – September 10, 2008



Appendix A

OU6 Rail Maintenance SAP Project-Specific Procedures and Libby Asbestos Site Standard Operating Procedures

Appendix B

Health and Safety Plan

Appendix C

Field Change Order (FCO) Form

Appendix D

Field Sample Data Sheets

Appendix E

Libby Asbestos Project Record of Modification Form

Appendix F

Analytical Requirements Summary